Italian Botanist 19: 185–203 (2025)
doi: 10.3897/italianbotanist.19.156865
https://italianbotanist.pensoft.net

RED LIST ASSESSMENTS

Italian Botanist
Published by Società Botanica Italiana

Global and Regional IUCN Red List Assessments: 18

Simone Orsenigo[1], Natalya Y. Beshko[2], Valentino Casolo[3], Miris Castello[4], Bekhruz S. Khabibullaev[2], Elisa Petrussa[3], Khabibullo F. Shomurodov[2], Laura R. Uliana[3], Giuseppe Fenu[5]

1 *Department of Earth and Environmental Sciences, University of Pavia, Via S. Epifanio 14, 27100, Pavia, Italy* **2** *Laboratory of Conservation and Ecology of Plants, Institute of Botany Academy of Sciences of Republic Uzbekistan, 100125 Tashkent, Uzbekistan* **3** *Modify in in Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, Via delle Scienze 99, 33100, Udine, Italy* **4** *Department of Life Sciences, University of Trieste, via Giorgieri 10, 34127, Trieste, Italy* **5** *Department of Life and Environmental Sciences, University of Cagliari, Viale S. Ignazio da Laconi 13, 09123, Cagliari, Italy*

Corresponding author: Simone Orsenigo (simone.orsenigo@unipv.it)

Academic editor: Lorenzo Peruzzi | Received 24 April 2025 | Accepted 17 June 2025 | Published 14 July 2025

Citation: Orsenigo S, Beshko NY, Casolo V, Castello M, Khabibullaev BS, Petrussa E, Shomurodov KF, Uliana LR, Fenu G (2025) Global and Regional IUCN Red List Assessments: 18. Italian Botanist 19: 185–203. https://doi.org/10.3897/italianbotanist.19.156865

Abstract

In this contribution, the conservation status assessment of four vascular plants according to IUCN categories and criteria are presented. It includes the assessment of *Phlomis nubilans* Zakirov and *Phlomoides anisochila* (Pazij & Vved.) Salmaki at global level and *Alyssum wulfenianum* Bernh. subsp. *wulfenianum* and *Noccaea cepaeifolia* (Wulfen) Rchb. at regional level.

Keywords

Conservation, extinction risk, IUCN protocol, threats

How to contribute

The text of the global and regional assessments should be submitted electronically to Simone Orsenigo (simone.orsenigo@unipv.it) or to Giuseppe Fenu (gfenu@unica.it); the text, up to 8000 characters in length (spaces included), must include a distribution map and a picture of the assessed species.

Copyright *Simone Orsenigo et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Red List Assessments

Alyssum wulfenianum Bernh. subsp. *wulfenianum*

Regional assessment (Italy)
Taxonomy and nomenclature
Order: Brassicales *Family*: Brassicaceae

Alyssum wulfenianum Bernh. ex Willd. subsp. *wulfenianum* Enum. Pl. Hort. Berol. Suppl.: 44 (1814) ["1813"] ≡ *Alyssum cuneifolium* Ten. subsp. *wulfenianum* (Bernh.) Hegi & Schmid. ≡ *Adyseton wulfenianum* (Willd.) Sweet = *Alyssum bernhardini* Wettst. = *Alyssum rochelii* Rchb.

Common name: Alisso di Wulfen (It), Karnisches Steinkraut (De).

Geographic distribution range: *Alyssum wulfenianum* subsp. *wulfenianum* (Fig. 1) is a narrow endemic to Italy and Austria, with a distribution restricted to a small area of the south-eastern limestone Alps in NE Friuli-Venezia Giulia, Julian Alps, and the Austrian border side in Kärnten (Fig. 2). The main distribution area lies in Italy, in Cave del Predil (UD) in the mine area and slopes of Mt. Re and in the underlying gravel riverbed of Rio del Lago; some individuals reach Tarvisio and the nearby areas of Austria, Gailtal, south of Villach, especially near Arnoldstein, along the rivers Gailitz and Gail; in Italy, it is also recorded from a few other sites in the Tarvisio area not directly connected to the Cave del Predil mine (Martini 1987, 2024; Fischer et al. 2008; Magauer et al. 2014; Martini et al. 2023).

Distribution: Countries of occurrence: Italy and Austria.

Biology: *Plant growth form*: perennial (suffruticose chamaephyte). *Chromosome number*: $2n = 16$ (Lausi and Cusma Velari 1992).

Flowering and fruiting time: Flowering from (May) June-July to August, fruiting from July to late August.

Reproduction: There are no specific studies on reproduction; it is assumed to be entomophilous.

Habitat and ecology: *Alyssum wulfenianum* subsp. *wulfenianum* grows on calcareous rocks, screes, debris and on gravel-sand riverbeds in the (sub)montane belt, often on sites with high concentrations of heavy metals (zinc and lead), at *ca*. 600–900 m a.s.l. (Magauer et al. 2014; Martini 2024). It is considered characteristic of the rare metalliferous association of the south-eastern Alps *Thlaspietum cepaeifolii* Ernst 1965 (*Thlaspion rotundifolii* alliance) (Englisch et al. 1993). It is an hyperaccumulator metallophyte (zinc, lead, thallium), favored by high concentration of metals in soil, as it mostly occurs in scattered sites characterized by natural contamination with lead or zinc and by mining activities (Fellet et al. 2012), where other plants are mostly unable to grow. On the contrary, it is a poor competitor on non-metalliferous soils.

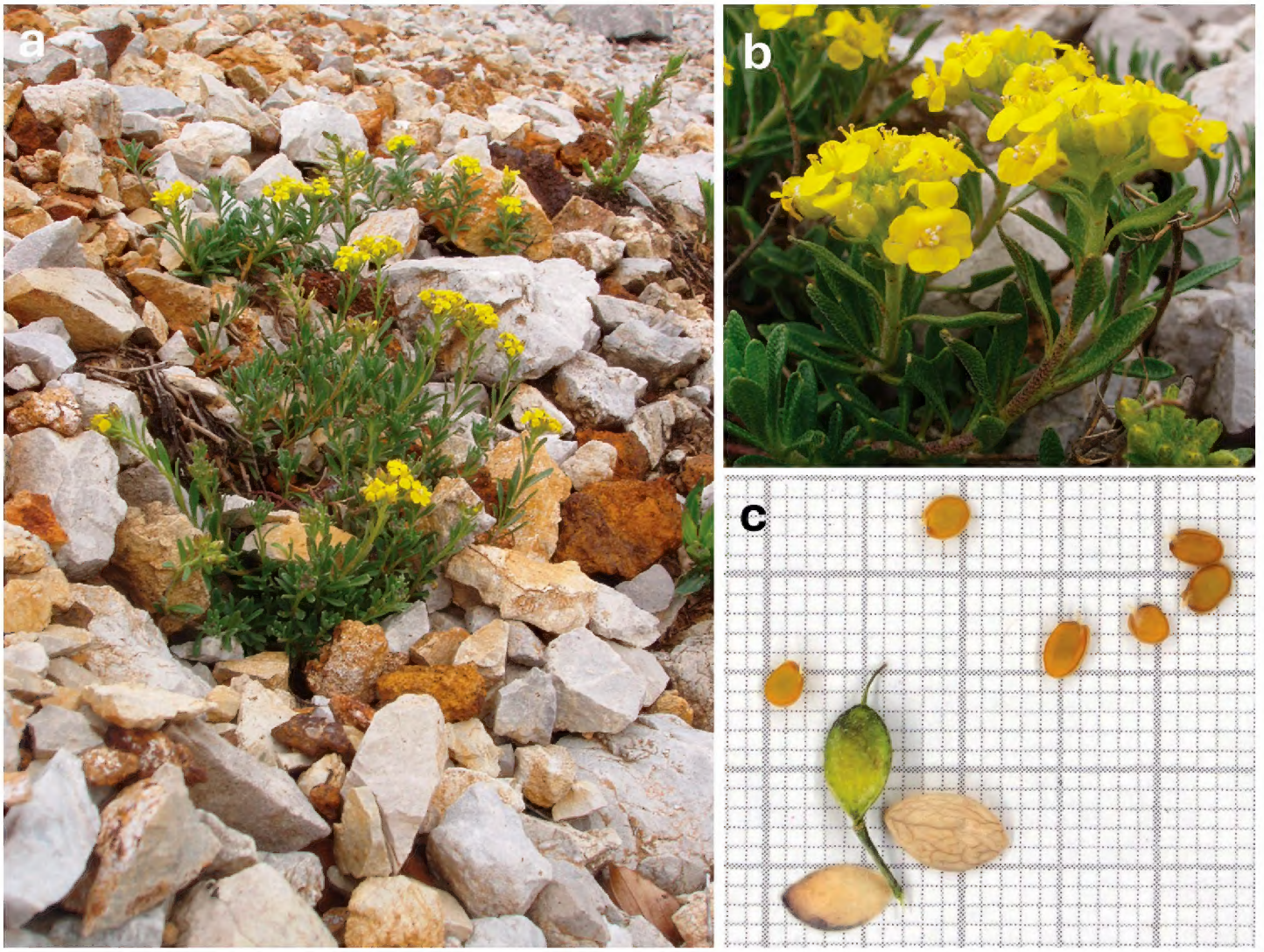

Figure 1. *Alyssum wulfenianum* subsp. *wulfenianum* in Cave del Predil (Udine) (Friuli Venezia Giulia, Italy) **a** plant growing on the metalliferous screes of Mt. Re mine (photograph by Valentino Casolo) **b** flowers (photograph by Valentino Casolo) **c** seed (photograph by Elisa Petrussa).

Population information: It occurs in fragmented populations with a limited number of individuals on rocky slopes and, primarily, gravel stream beds and banks strongly influenced by river dynamics and human activities (gravel extraction and changes in the regimes of rivers) (Fellet et al. 2012; Magauer et al. 2014). In Italy, subpopulations are mainly found in the Rio del Lago valley, with *ca.* 3,600 individuals; they are stable in the mining areas of Cave del Predil (quarry of Piccolo Mt. Re) and very fluctuating in the bed of the underlying stream Rio del Lago. A reduction of individuals for change of habitat quality is expected in the future due to cessation of mining activities and mostly to the remediation work of the mine site of Cave del Predil started in recent years.

Threats:

6.1 Recreational activities: The Raibl-Cave del Predil mine, closed in 1991, has become an international geomineral park, and the whole area of Cave del Predil is affected by initiatives aimed at promoting tourism; recreational activities could increase in the future and some populations are already negatively affected by human trampling.

7.3 Other ecosystem modifications: The cessation of mining activities and the recent extensive post-mining remediation works including covering and embankment of sedimentation basins of mining waste, hydrological regulation works and gravel extraction along the

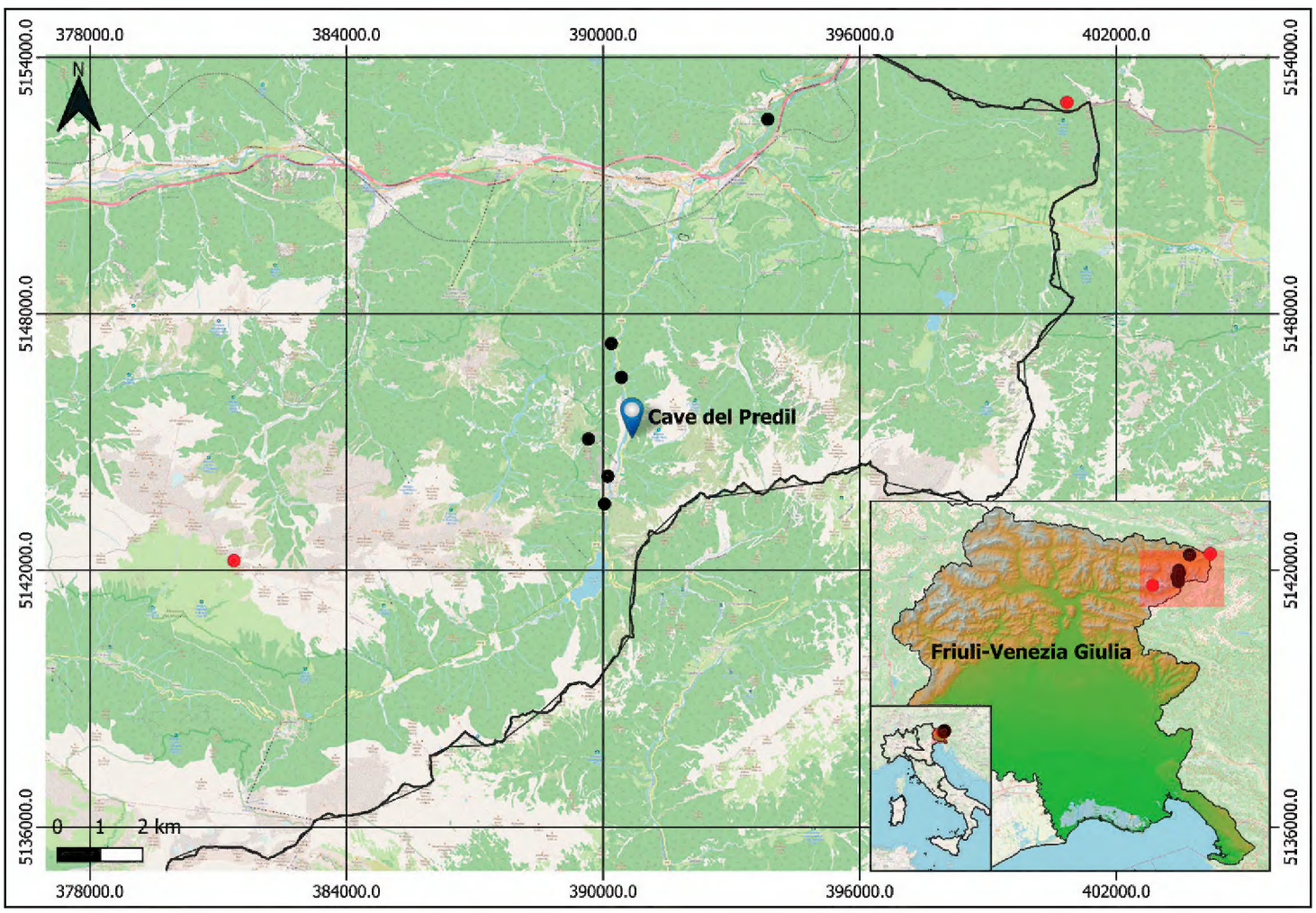

Figure 2. Geographic range and distribution map of *Alyssum wulfenianum* subsp. *wulfenianum* in Italy. Red dots: centroids of the quadrants of the Central European floristic mapping grid from Martini et al. (2023) (sites with imprecise location); black dots: sites with precise location (source of data: IRDAT FVG)

stream Rio del Lago, as well as phytoremediation of metal-contaminated soil could cause a natural change of the habitat, supporting non-metal-tolerant species and vegetation succession, site alteration or destruction, thereby causing a decline of the fragile populations.

CRITERIA APPLIED

Criterion B: **EOO:** 60.2 km^2 calculated with minimum convex hull in QGis 3.28.13.
AOO: 20 km^2 calculated with a 2×2 km-cell fixed grid.

a) Number of locations ≤ 5.
b) Continuing decline in: ii) area of occupancy; iii) area, extent and/or quality of habitat; iv) number of locations or subpopulations; v) number of mature individuals.

Red List category and criteria (Regional Assessment)

EN	**Endangered**	**B1ab(ii,iii,iv,v)+ 2ab(ii,iii,iv,v)**

Rationale for the assessment: *Alyssum wulfenianum* subsp. *wulfenianum* is a stenoendemic with a distribution centered in the Rio del Lago valley (W Julian Alps) at the lead and zinc mines of Cave del Predil (Raibl) with a population size of about 3,600 mature

individuals. The EOO and AOO are estimated to be *ca.* 60 km² and 20 km², respectively; there is no severe fragmentation, and the number of locations can be estimated to be no more than five based on the main threat (ecosystem modifications). No information is available on extreme fluctuations. The habitat of the taxon could be modified by the cessation of the mining activity (in 1991) and the recent post-mining remediation of the contaminated soils, resulting in a potential decline and disappearance of subpopulations. In fact, except for the subpopulation of the slopes of Mt. Re, the subpopulations of the bottom valley at the mine site and along riverbanks are in decline and highly fluctuating. In addition, human trampling could pose a serious threat to some subpopulations. The Red List category was not changed in relation to populations in neighboring areas, as the regional population does not experience immigration from the nearby Austrian population, that is smaller and currently qualifies as Critically Endangered (Schratt-Ehrendorfer et al. 2022). Therefore, the species is assigned to the Endangered (EN) category at the Italian regional level.

Previous assessment: At the Italian regional level, this taxon has not yet been evaluated, however *A. wulfenianum* Bernh. s.l. (including *Alyssum wulfenianum* Bernh. subsp. *ovirense* (A.Kern.) Magauer, Schönsw. & Frajman) was evaluated as Least Concern (LC) in Italy (Orsenigo et al. 2021). *A. wulfenianum* subsp. *wulfenianum* is included in the Red List of Austria (Schratt-Ehrendorfer et al. 2022) as Critically Endangered (CR) and is protected in Carinthia by local legislation. At the global level it has been evaluated as Endangered (EN) by Magauer et al. (2014).

Conservation actions: In Italy, at both national and regional levels, it is not protected by law. One accession collected in 2024 at Cave del Predil (Udine) is stored *ex situ* in the Germplasm Bank of Friuli-Venezia Giulia of the University of Udine (BaGAV, ITA368 - AW_P_2024_1).

Conservation actions needed: Research studies and monitoring programs are urgently needed to better understand the reproductive biology, environmental factors affecting reproduction, population trends and to evaluate the possible impact of threats, in particular mining remediation and heavy flooding. It is necessary to consider *in situ* conservation measures and targeted protection of contaminated areas in order to preserve metallophyte species, as the regional plan foresees remediation of the mining area of Cave del Predil. Increasing the number of accessions in seed banks for *ex situ* conservation is also recommended.

Laura Rosa Uliana, Elisa Petrussa, Valentino Casolo, Miris Castello

Noccaea cepaeifolia (Wulfen) Rchb.

Regional assessment (Italy)

Taxonomy and nomenclature

Order: Brassicales *Family*: Brassicaceae

Noccaea cepaeifolia (Wulfen) Rchb., Fl. Germ. Excurs.: 663 (1832) ≡ *Iberis cepaeifolia* Wulfen in Jacquin, Misc. Austriac. 2: 28 (1781) ≡ *Hutchinsia cepaeifolia* (Wulfen) DC., Reg. Veg. Syst. Nat. 2: 386 (1821) ≡ *Thlaspi cepaeifolium* (Wulfen) W.D.J.

Koch. in J.C.Röhling, Deutschl. Fl. ed.3, 4: 534 (1833) ≡ *Thlaspi rotundifolium* subsp. *cepaeifolium* (Wulfen) Rouy & Foucaud, Fl. France 2: 157 (1895) ≡ *Thlaspi rotundifolium* f. *cepaeifolium* (Wulfen) Bolzon, Nuovo Giorn. Bot. Ital., n.s., 20: 305 (1913).

Common name: Erba-storna a foglie di cipolla, Tlaspi con foglie di sedo cepa (It), Dickblatt-täschelkraut (De).

Geographic distribution range: *Noccaea cepaeifolia* (Fig. 3) is a steno-endemic species of the calcareous SE Alps occurring in the border area between NE Friuli Venezia Giulia, W Julian Alps (Italy) and Carinthia (Austria) (Aeschimann et al. 2004; Fischer et al. 2008; Martini 2024). Its range is centered in Italy in the area of Cave del Predil (Udine), where the *locus classicus* of the entity is found, on the mine slopes of Mt. Re and the river gravels of the underlying Rio del Lago (Fig. 4); some individuals reach Tarvisio (Martini 1987, 2024) and Austria, Karnten, Gailtal, where it is only found near Arnoldstein in the gravelly riverbed of the Gailitz (Fischer et al. 2008). The old records from the Carnic Alps (NW Friuli Venezia Giulia) by Gortani and Gortani (1905–1906) have never been confirmed and are considered dubious.

Distribution: *Countries of occurrence*: Italy and Austria.

Biology: *Plant growth form*: perennial (suffruticose chamaephyte). *Chromosome number*: $2n = 14$ (Antkowiak et al. 2018).

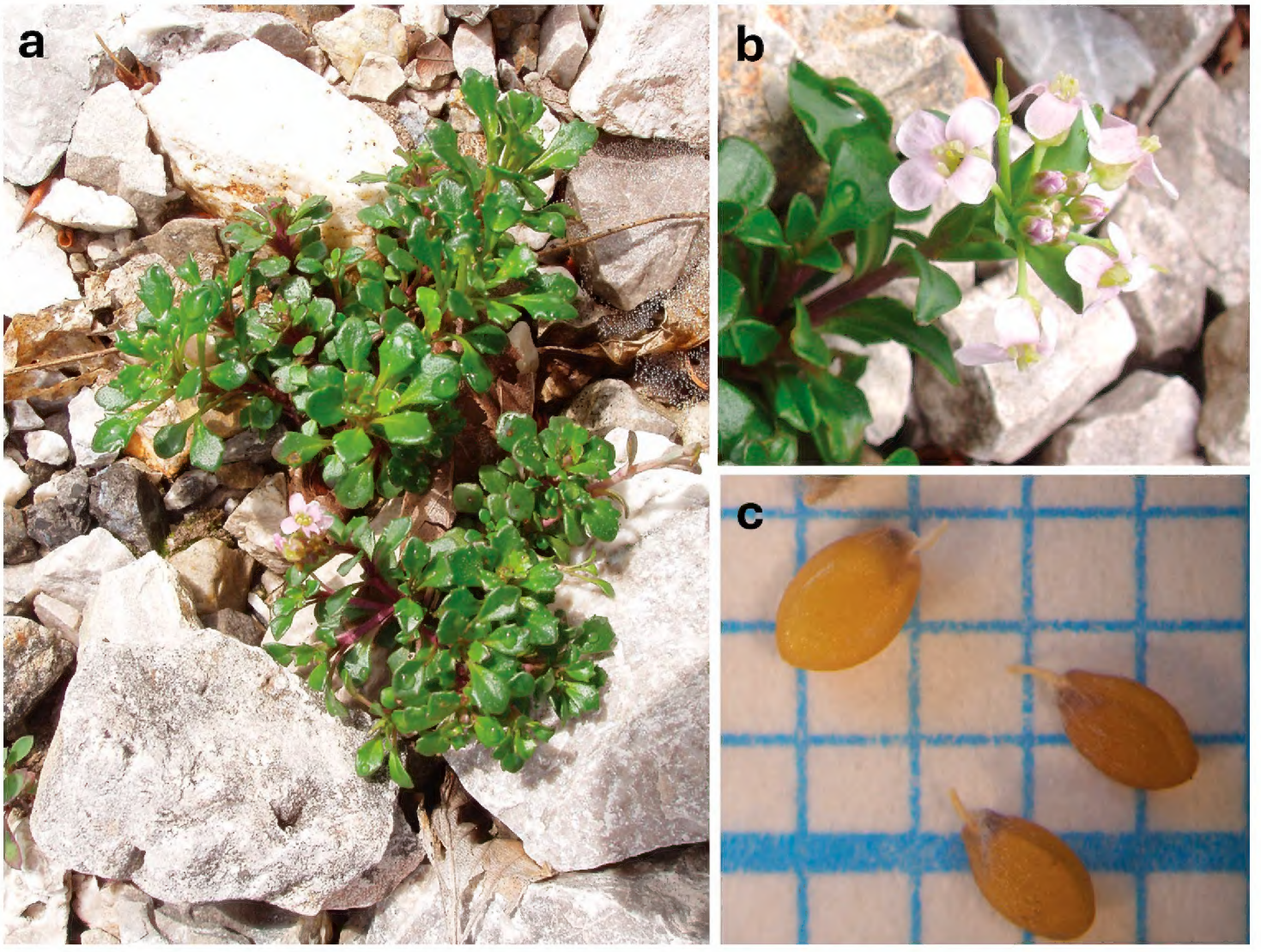

Figure 3. *Noccaea cepaeifolia* photographed at Cave del Predil (Udine) (Friuli Venezia Giulia, Italy) **a** plant growing on the metalliferous screes of Canale Bastiani (photograph by Luca Marchiol) **b** flowers (photograph by Valentino Casolo) **c** seeds (photograph by Elisa Petrussa).

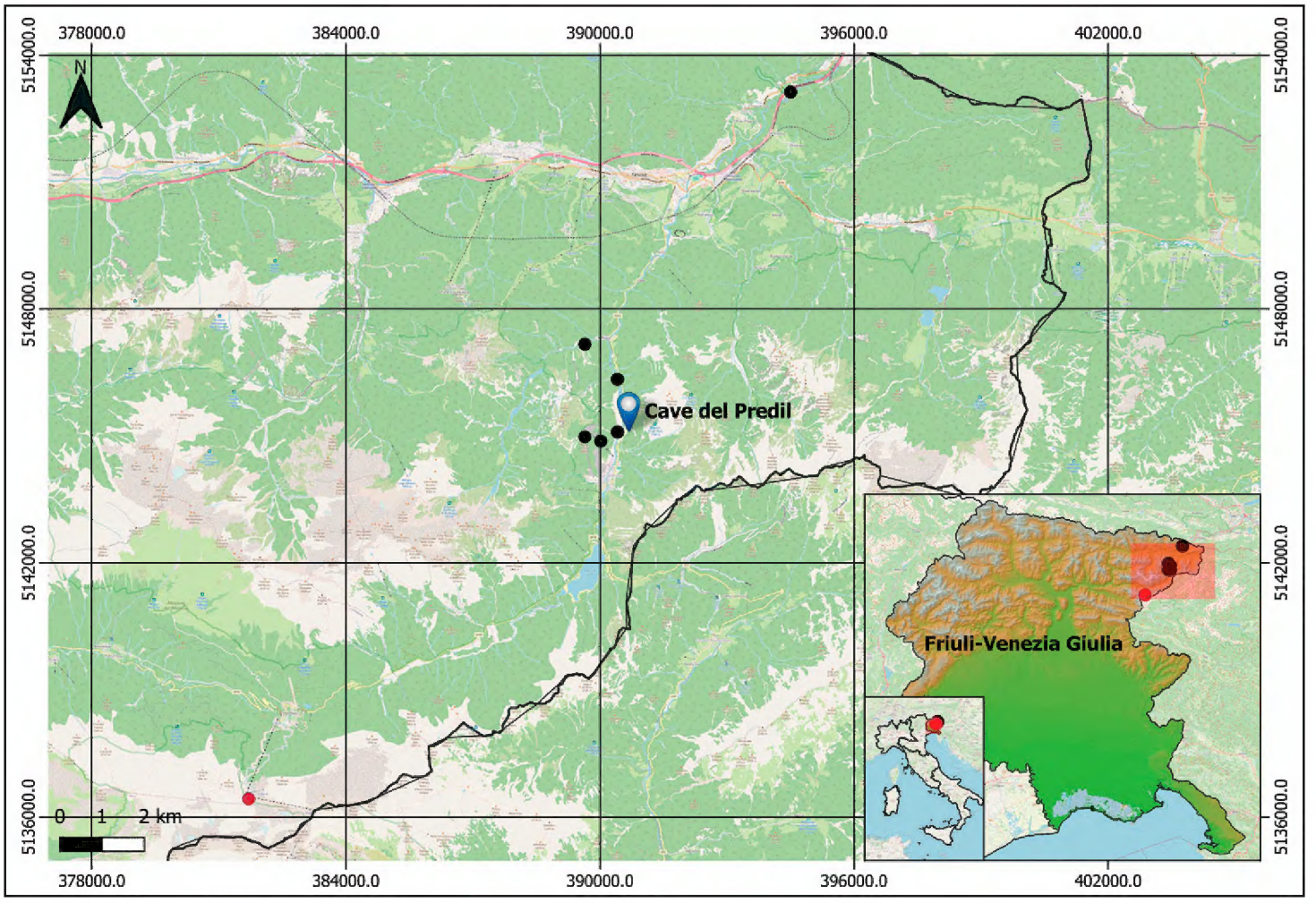

Figure 4. Geographic range and distribution map of *Noccaea cepaeifolia* in Italy. Red dots: centroids of the quadrants of the Central European floristic mapping grid from Martini et al. (2023) (sites with imprecise location); black dots: sites with precise location (source of data: IRDAT FVG).

Flowering and fruiting time: Flowering from June to August, fruiting from July to late August.

Reproduction: Detailed information on reproduction, pollination, dispersal strategy and seed germination is absent. Reproduction likely involves specific pollinators, potentially affected by metal accumulation in floral structures, as observed in other species of the genus (Jakovljević et al. 2024). Dispersal by seeds.

Habitat and ecology: In Italy, *N. cepaeifolia* grows on calcareous rock slopes, screes and river gravels and sands in the montane and subalpine belts, mostly near anthropogenic metalliferous habitats (spoils and tailings of lead and zinc mining) in Cave del Predil (W Julian Alps) (Martini 1987; Punz and Mucina 1997; Fellet et al. 2012; Martini 2024), which was one of the most important lead and zinc mines in Europe. It is an hyperaccumulator, characteristic of the very rare association *Thlaspietum cepaeifolii* described by Ernst (1974) from heavy metal-rich scree slopes of the SE Alps and restricted to the mining areas of Raibl-Cave del Predil (see Punz and Mucina 1997). As a metallophyte, *N. cepaeifolia* is a poor competitor in soils not rich in heavy metals.

Population information: *Noccaea cepaeifolia* occurs in several scattered subpopulations, with size ranging from few to thousands of individuals, which are strongly influenced by human activities and river dynamics (mining activities, gravel extraction and changes in the regimes of rivers) (Fellet et al. 2012; Martini 2024). Subpopula-

tions seem to be stable in former mining areas of Cave del Predil or in the nearby Canale Bastiani (on the slopes of Mt. Re) and adjoining mining deposits, whereas they are very fluctuating in the bed of the stream Rio del Lago. A population reduction is expected in the future for a change of habitat quality related to cessation of mining activities and mostly to riverbed arrangement works, gravel extraction, and remediation of the mine site of Cave del Predil that began in recent years.

Threats:

6.1 Recreational activities: The Raibl-Cave del Predil mine, closed in 1991, has become an international geomineral park, and the whole area of Cave del Predil is interested by initiatives to promote tourism: recreational activities could increase in the future and some subpopulations could be negatively affected by human trampling.

7.3 Other ecosystem modifications: The cessation of mining activities and the post-mining remediation actions including covering and embankment of sedimentation basins of mining waste, hydrological regulation works and gravel extraction along the stream Rio del Lago, and phytoremediation actions for the decontamination of soils are likely to lead to alteration and degradation of the habitat of this narrow-endemic metallophyte, with a consequent decline of this vulnerable species strictly dependent on natural or anthropogenic heavy metal-rich substrates.

CRITERIA APPLIED:

Criterion B: **EOO:** 21.5 km^2 calculated with minimum convex hull in QGis 3.28.13.
AOO: 16 km^2 calculated with a 2×2 km-cell fixed grid.

a) Number of locations ≤ 5.
b) Continuing decline in: ii) area of occupancy; iii) area, extent and/or quality of habitat; iv) number of locations or subpopulations; v) number of mature individuals.

Red List category and criteria (regional assessment)

EN	**Endangered**	**B1ab(ii,iii,iv,v)+ 2ab(ii,iii,iv,v)**

Rationale for the assessment: In Italy *Noccaea cepaeifolia* is present only in NE Friuli Venezia Giulia, in the area of Cave del Predil (Raibl) and a few other nearby sites (Coccau and mountain area southwest of Cave del Predil). The majority of the population is found at the lead and zinc mines of Raibl-Cave del Predil in the Rio del Lago valley (Julian Alps), estimated by direct observation to be a few thousand individuals; a few other small, scattered subpopulations are known. The EOO and AOO are reduced; there is no severe fragmentation, and the number of locations can be estimated to be no more than 5 according to main threat (ecosystem modifications). No information is available on extreme fluctuations. Cessation of the mining activity (in 1991) and, especially, the recent post-mining riverbed arrangement works, gravel extraction and remediation of the contaminated soils could heavily modify the habitat of this species with the consequent potential decline and disappearance

of subpopulations. In fact, a decline of the number of individuals has already been observed in the subpopulations growing at lower altitudes. In addition, human trampling could pose a serious threat to some subpopulations. Therefore, based on criterion B, the species can be classified as Endangered (EN) at the Italian regional level. The species is rare and in strong decline in nearby Austria (Schratt-Ehrendorfer et al. 2022). Consequently, the assessment is not downlisted.

Previous assessment: At the regional level (Italy) and at the global level (IUCN 2024) the species has never been evaluated. *Noccaea cepaeifolia* is included in the Red List of Austria (Schratt-Ehrendorfer et al. 2022) as Critically endangered (CR).

Conservation actions: *Noccaea cepaeifolia* is included in the Red List of Austria (Schratt-Ehrendorfer et al. 2022) as Critically endangered (CR). It is unprotected by international and Italian national and regional legislation. One accession collected in 2024 at Cave del Predil (UD) is stored *ex situ* in the Germplasm Bank of Friuli Venezia Giulia of the University of Udine (BaGAV, ITA368 - NC_P_2024).

Conservation actions needed: Research studies are recommended aiming at gaining better knowledge on the reproductive biology and environmental factors affecting reproduction; monitoring programs could help to evaluate population dynamics and the possible development of threats to the species, such as habitat degradation or invasive species colonization. The increase in the number of accessions in seed banks for *ex situ* conservation is also suggested. Specific *in situ* interventions should be undertaken to preserve small-scale sites with high heavy metal concentrations in soil, to control the natural ecological succession, and for population reinforcement.

Valentino Casolo, Laura Rosa Uliana, Elisa Petrussa, Miris Castello

Phlomis nubilans Zakirov

Global assessment
Taxonomy and nomenclature
Order: Lamiales *Family*: Lamiaceae

Phlomis nubilans Zakirov, Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbeksk. S.S.R. 9: 3 (1947).

Common name: Jerusalem sage (En); зопник мрачный (Rus); Ko'rimsiz qo'ziquloq (Uzb).

Geographic distribution range: *Phlomis nubilans* (Fig. 5) is a perennial herb 30–40 cm tall, national endemic of Uzbekistan with restricted geographic range, and endemic to the Nuratau Mountains in the north-western part of Pamir-Alay Mountain system (Beshko 2018, 2020; Tojibaev et al. 2018, 2021; Khassanov et al. 2019; Volis and Beshko 2023). This species is distributed in central part of Uzbekistan, mainly in Farish, Gallaaral and Sharof Rashidov Districts of Jizzakh Region, Nurata and Khatyrchi Districts of Navoi Region, Koshrabad and Payaryk Districts of Samarkand Region (Fig. 6).

Distribution: *Countries of occurrence*: Uzbekistan.

Figure 5. *Phlomis nubilans* Zakirov from Nuratau Range (Uzbekistan, Jizzakh Region). Photo by Natalya Y. Beshko.

Biology: *Plant growth form*: perennial (hemicryptophyte).

Flowering and fruiting time: flowering in June–August, fruiting in July–September (Vvedensky 1961; Makhmedov 1987; Beshko 2020).

Reproduction: Propagation by seeds. The detailed information on reproductive biology of this species (pollination, dispersal strategy, seed germination) is not available.

Habitat and ecology: *P. nubilans* is a perennial plant with short-branched caudex, which grows on stony, shistaceous and fine-earth slopes and sometimes on rocks and screes in foothills and montane zone, at altitudes from 700–800 to 2,100 m a.s.l. (Beshko 2018; Tojibaev et al. 2018, 2019, 2021; Khassanov et al. 2019). It occurs among open shrublands dominated by *Prunus bucharica* (Korsh.) B.Fedtsch. ex Rehder, *P. spinosissima* (Bunge) Franch. and *Lonicera nummulariifolia* Jaub. & Spach, forb-grass and forb-sagebrush communities [*Arctium korolkowii* (Regel & Schmalh.) Kuntze, *Artemisia tenuisecta* Nevski, *Dianthus helenae* Vved., *Ferula ovina* Boiss., *Festuca valesiaca* Schleich. & Gaudin, *Hypericum scabrum* L., *Prangos pabularia* Lindl., *Poa bulbosa* L., *P. versicolor* Besser, *Trichopyrum intermedium* (Host) Barkworth & D.R.Dewey, *Ziziphora clinopodioides* Lam.] and communities of pulvinate subshrubs (*Acantholimon erythraeum* Bunge, *A. nuratavicum* Zakirov, *Acanthophyllum knorringianum* Schischk.). Nuratau Range hosts a signifi-

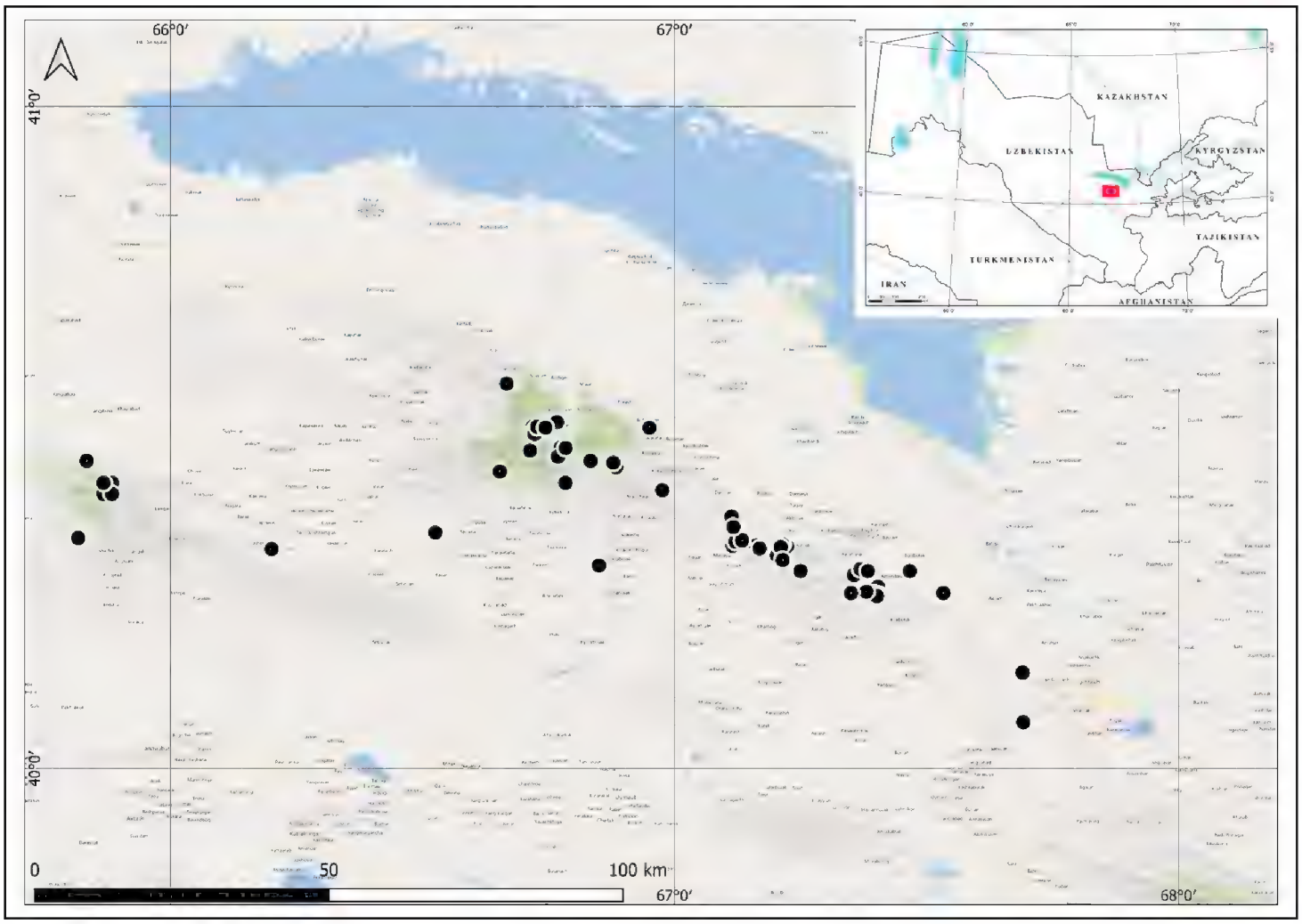

Figure 6. Geographic range and distribution map of *Phlomis nubilans* in the Nuratau Mountains (Uzbekistan).

cant number of threatened, endemic and subendemic plant species, some of them [*Acantholimon nuratavicum*, *Arctium pallidivirens* (Kult.) S.Lopez, Romanschenko, Susanna & N.Garcia, *Dracocephalum nuratavicum* Adylov, *Oxytropis pseudorosea* Filim., *Parrya nuratensis* Botsch. & Vved., *Salvia submutica* Botsch. & Vved.] form unique communities together with *Phlomis nubilans*.

Population information: *P. nubilans* usually occurs in groups of 20–30 to 450–500 individuals, rarely solitary. In total, to date, 71 occurrence records (localities) are known for this plant. Based on the field studies performed during the last 10 years, the total population size was estimated at about 50,000–100,000 individuals (Volis and Beshko 2023). The significant part of known populations of *P. nubilans* (about 90%) grows on the Nuratau Range, and the lesser part occurs on the Aktau Range, about 17% of populations are protected in the Nuratau Nature Reserve. Field data shows that populations that grow outside of the nature reserve are decreasing, and the extent and quality of species habitats are declining due to overgrazing, agriculture, geological exploration and mining. The demographic structure of populations of this species is poorly studied, and the available data are rather contradictory. Only generative specimens were found in two populations surveyed by Akhmedov et al. (2023) and located in the central part of Nuratau Range, while we observed numerous young plants of different age stages in the nearby area in 2024.

Threats:

2.1 Annual & perennial non-timber crops (*2.1.2 Small-holder farming*): Last 10–20 years, the active agricultural development of virgin lands occurs in the Nuratau Mountains. Gentle slopes are being developed by local people and farmers into non-irrigated and irrigated arable lands and orchards. This leads destruction of populations of *P. nubilans* and habitat loss.

2.3 Livestock farming & ranching (*2.3.1 Nomadic grazing* and 2.3.2 *Small-holder grazing, ranching or farming*): for a long time, the mountain pastures of the Nuratau Range are subject to excessive grazing everywhere, even on the territory of the nature reserve and its buffer zone, where illegal grazing occurs regularly. Livestock do not eat this plant, but trample young specimens, and in addition, overgrazing leads to habitat degradation and soil erosion. Overgrazing is the main indirect threat for populations of *P. nubilans*.

3.2 Mining & quarrying: The serious direct threat for populations of *P. nubilans* that leads to populations destroying and habitat loss is connected with geological exploration, mining and quarrying. There are deposits of gold, marble and other minerals in the Nuratau mountains. Consequently, large-scale geological exploration, mining operations, and quarrying have been carried out in this region since Soviet times. In the last 10 years, these activities, as well as the development of related infrastructures, have increased significantly.

10.3 Avalanches/landslides: On steep mountain slopes, a significant part of seedlings and young plants are eliminated as a result of avalanches and mudflows.

11 Climate change & severe weather (11.1 Habitat shifting & alteration and 11.2 Droughts). *P. nubilans* is relatively tolerant to drought, but the results of species distribution modeling (SDM) demonstrate that a suitable range of this species will decrease significantly with further climate aridization (scenario RCP8.5), and the extinction risk of this species will increase (Volis and Beshko 2023).

CRITERIA APPLIED

Criterion B: **EOO:** 4,381.61 km^2 calculated with a GeoCAT (Geospatial Conservation Assessment Tool) software (Bachman et al. 2011).
AOO: 172 km^2 calculated with GeoCAT software using 2×2 km cells (Bachman et al. 2011).

b) Continuing decline, observed in area of occupancy (ii), extent and quality of habitat (iii), number of locations or subpopulations (iv).

Red List category and Criteria (Global Assessment)

NT	**Near Threatened**	

Rationale for the assessment: *Phlomis nubilans* is an endemic species with restricted distribution range. The species has an estimated total population of about 50,000–100,000 mature individuals, extent of occurrence of 4,381.61 km^2 and an

area of occupancy of 172 km^2. The populations and habitats of this species are affected by human activities as agriculture, livestock farming and mining industry, as well as by climate change. By applying criterion B, considering the existence of identified threats, which remain unmitigated, the condition of species habitat and populations is projected to deteriorate in the future. Although the species meets the area requirements under criterion B for Endangered (EOO <5,000 km^2 and AOO <500 km^2) and is declining, the population is not severely fragmented; overall population size is over 10,000 mature individuals, the number of locations is more than 10, and there are no extreme fluctuations. Therefore, in accordance with "Guidelines for Using the IUCN Red List Categories and Criteria" (IUCN 2022), this species can be assessed as Near Threatened (NT) at a global level.

Previous assessment: The taxon has never been assessed at the global level (IUCN 2024).

Conservation actions: *Phlomis nubilans* is included in the actual edition of the Red Data Book of Uzbekistan under category 3 (more or less corresponds with IUCN category VU) (Khassanov et al. 2019). In previous editions of the National Red Data Book, it has been listed under category 2 (rare, endangered). The species is not cultivated *ex situ*, and its seeds are not conserved in any germplasm bank.

Conservation actions needed: Expansion of the territory of the Nuratau Nature Reserve, regulation of livestock grazing and prohibition of mining and geological exploration in the species habitats. Research and monitoring activities are recommended to better understand the reproductive biology of the species, ecology, threats, and population trends, as well as the development of cultivation methods and seed banking.

Giuseppe Fenu, Natalya Y. Beshko, Khabibullo F. Shomurodov, Bekhruz S. Khabibullaev

Phlomoides anisochila (Pazij & Vved.) Salmaki

Global assessment
Taxonomy and nomenclature
Order: Lamiales *Family*: Lamiaceae

Phlomoides anisochila (Pazij & Vved.) Salmaki, Taxon 61: 175 (2012) ≡ *Paraeremostachys anisochila* (Pazij & Vved.) Adylov, Kamelin & Makhm., Novosti Sist. Vyssh. Rast. 23: 113 (1986); *Eremostachys anisochila* Pazij & Vved., Fl. Uzbekistan. 5: 634 (1961).

Common name: unequal-lipped phlomoides (En); фломоидес неравногубый (Rus); учпояли оқтӯша, тенгсиз лабли фломоидес (Uzb).

Geographic distribution range: *Phlomoides anisochila* (Fig. 7) is a perennial herb 15–25 cm tall, with thickened tuberous roots. It is endemic to Uzbekistan with narrow distribution range and small populations. This species occurs only on the Nuratau Range in the north-western part of Pamir-Alay Mountain system,

Figure 7. *Phlomoides anisochila* (Pazij & Vved.) Salmaki from Nuratau Nature Reserve, Nuratau Range (Uzbekistan, Jizzakh Region). Photo by Natalya Y. Beshko.

mainly in Farish District of Jizzakh Region, some populations occur in Koshrabad and Payaryk Districts of Samarkand Region of Uzbekistan (Beshko 2018, 2020; Tojibaev et al. 2018, 2021; Khassanov et al. 2019; Volis and Beshko 2023). The majority of known populations are located in the central part of the Nuratau Range, between valleys Saparsay, Nakrutsay and Sentobsay, and one isolated record is reported from the eastern part of the Nuratau Range, upstream of the village Koytash, about 45 km to the south-east of the other populations (Fig. 8).

Distribution: *Countries of occurrence*: Uzbekistan.

Biology: *Plant growth form*: perennial (hemicryptophyte).

Flowering and fruiting time: flowering in May–June, fruiting in June–August (Vvedensky 1961; Adylov 1987; Beshko 2020).

Reproduction: Propagation by seeds. No detailed information on reproductive biology of this species is available. It seems that *P. anisochila* has a low reproductive rate and low competition capacity.

Habitat and ecology: *Phlomoides anisochila* is a perennial plant which grows on dry stony and shistaceous slopes, watersheds, in crevices of rocks and sometimes on screes in montane zone, at altitudes from 1,600 to 2,100 m a.s.l., in sparse communities of xerophytic shrubs [*Atraphaxis karataviensis* Lipsch. & Pavlov, *A. virgata* (Regel) Krasn.,

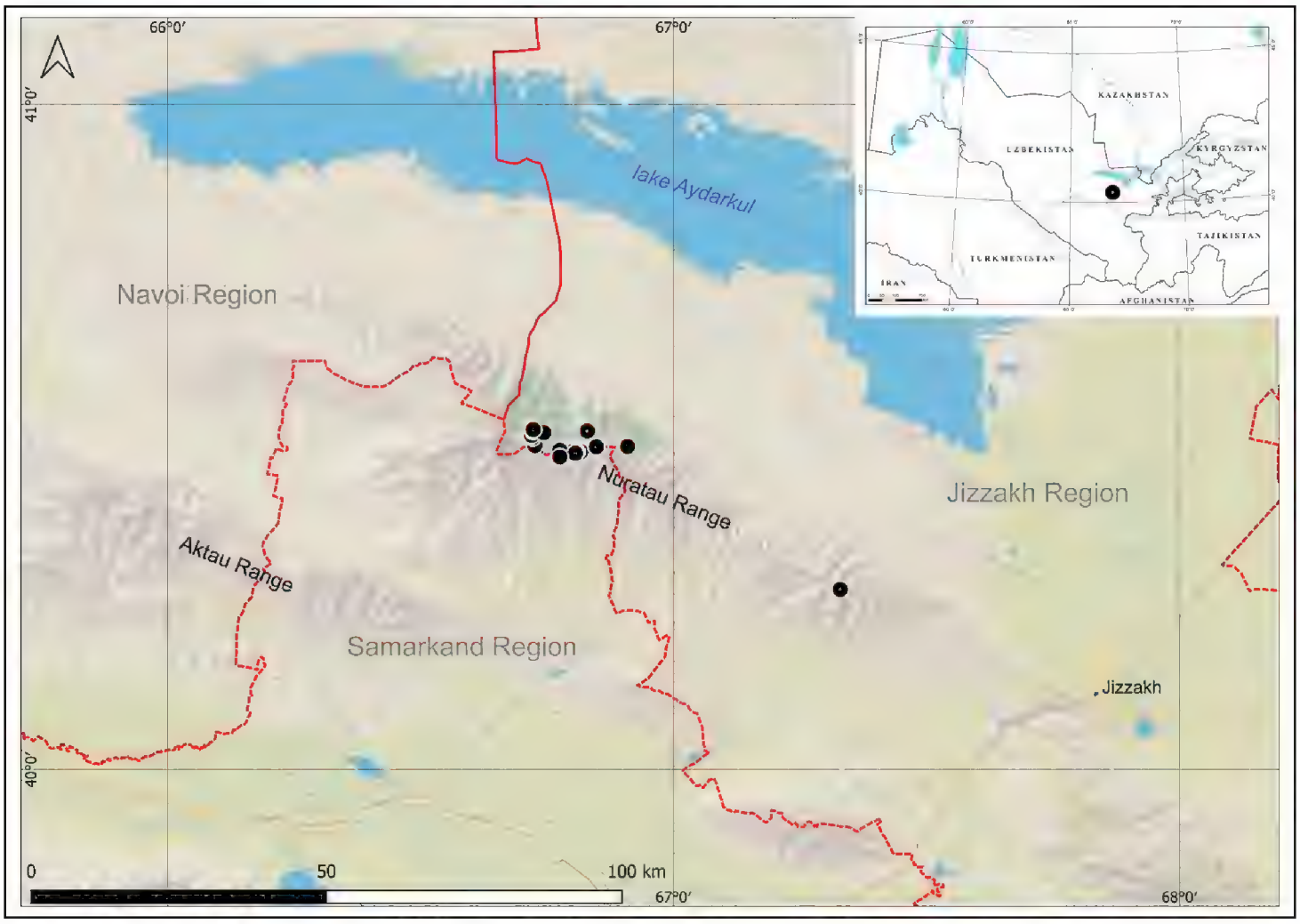

Figure 8. Geographic range and distribution map of *Phlomoides anisochila* on the Nuratau Range (Uzbekistan).

Rosa webbiana Wall. ex Royle), subshrubs (*Galatella grimmii* (Regel & Schmalh.) Sennikov], sagebrush (*Artemisia juncea* Kar. & Kir., *A. tenuisecta* Nevski), pulvinate subshrubs (*Acantholimon erythraeum* Bunge, *A. nuratavicum* Zakirov, *Acanthophyllum knorringianum* Schischk.), forbs (*Ferula ovina* Boiss., *Hypericum scabrum* L., *Ziziphora clinopodioides* Lam., etc.) geophytes (*Tulipa korolkowii* Regel, *T. turkestanica* Regel) and grasses (*Leymus angustus* (Trin.) Pilg., *Piptatherum sogdianum* (Grig.) Roshev., *Poa bulbosa* L., *P. versicolor* Besser). Nuratau Range hosts a significant number of threatened, endemic and subendemic plant species; some of them (*Acantholimon nuratavicum*, *Dracocephalum nuratavicum* Adylov, *Oxytropis pseudorosea* Filim., *Parrya nuratensis* Botsch. & Vved., *Salvia submutica* Botsch. & Vved.) form unique communities together with *P. anisochila*. The habitats of this species are characterized with strongly rugged terrain with steep rocky slopes and screes with unstable substrate, which is an obstacle for thorough counting and monitoring of populations.

Population information: *Phlomoides anisochila* occurs in small, isolated groups 10–30 to 50–70, rarely to 100–200 individuals. In total, 34 occurrence records (localities) have been documented since 1931, when this species was discovered for the first time. The field studies performed during the last 10 years have documented about 1,000 individuals of *P. anisochila*, with extreme fluctuations in number of mature individuals depending on climatic factors (Beshko 2018; Tojibaev et al. 2018, 2021;

Khassanov et al. 2019; Volis and Beshko 2023). The majority of known populations of this species are protected in the Nuratau Nature Reserve. As revealed by our field observations, populations that grow outside of the nature reserve are decreasing due to overgrazing and geological exploration. No data on demographic structure of populations of this species is available.

Threats:

2.3 Livestock farming & ranching (*2.3.1 Nomadic grazing* and 2.3.2 *Small-holder grazing, ranching or farming*): For a long time, the mountain pastures of the Nuratau Range are subject to excessive grazing everywhere, even on the territory of the nature reserve and its buffer zone, where illegal grazing occurs regularly. Overgrazing is the main direct and indirect threat for populations of *P. anisochila* as well as for other rare species (Fenu et al. 2022) by causing habitat degradation, reducing population density through direct consumption, and disrupting the species' ability to regenerate. Direct threat is connected with grazing and trampling of *P. anisochila* individuals, especially seedlings and young plants. Indirect threat is connected with soil erosion and habitat degradation as a result of intensive pasture load.

3.2 Mining & quarrying: There are deposits of gold and other minerals in the Nuratau mountains; as a result, large-scale geological exploration and mining operations have been carried out in this region since Soviet times. In the last 10 years, geological exploration has intensified significantly, even in the buffer zone of the nature reserve. This is a serious direct threat leading to population destruction and habitat loss.

10.3 Avalanches/landslides: On strongly eroded steep slopes with unstable stony substrate, a significant part of seedlings and young plants are eliminated as a result of avalanches and mudflows.

11 Climate change & severe weather (11.1 Habitat shifting & alteration and 11.2 Droughts): Droughts occurs regularly (every 5–6 years) in the region of Nuratau Range and adjacent Kyzylkum Desert. As shown by our field observations, the number of flowering and fruiting individuals of *P. anisochila* in dry years is extremely low. In addition, the results of species distribution modeling (SDM) demonstrate that the suitable range of this species will decrease significantly with further climate change, mainly increasing drought (scenario RCP8.5), thereby increasing the extinction risk of this species (Volis and Beshko 2023).

CRITERIA APPLIED

Criterion B: **EOO:** 214.5 km^2 calculated with a GeoCAT (Geospatial Conservation Assessment Tool) software (Bachman et al. 2011).
AOO: 40 km^2 calculated with GeoCAT software using 2×2 km cells (Bachman et al. 2011).

b) Continuing decline, observed in area of occupancy (ii), extent and quality of habitat (iii), number of locations or subpopulations (iv).
c) Extreme fluctuations, observed in number of mature individuals (iv).

Criterion C: Population size estimated to be less than 2,500 mature individuals (the total population size is estimated at about 1,000 individuals).

2a) Number of mature individuals in largest subpopulation is less than 250.
b) Extreme fluctuations, observed in number of mature individuals.

Red List category and Criteria (Global Assessment)

EN	**Endangered**	**B1bc(ii,iii,iv)+B2bc(ii,iii,iv)+C2ab**

Rationale for the assessment: *Phlomoides anisochila* is species with restricted distribution range, with very small subpopulations, low reproductive rate and competition capacity. The species has an estimated total population of about 1,000 mature individuals (with observed extreme fluctuations and the number of mature individuals in largest subpopulation less than 250), EOO of 214.5 km² and AOO of 40 km². Despite the significant part of known populations of this species growing in the protected area, they are affected by human activities as livestock farming and geological exploration, as well as by climate change. By applying criteria B and C, considering the presence of identified threats, which remain unmitigated, the condition of species habitat and populations is projected to deteriorate in the future. Therefore, this species meets quantitative requirements of criteria B and C and can be assessed as Endangered (EN) at a global level.

Previous assessment: The taxon has never been assessed at the global level (IUCN 2024).

Conservation actions: *Phlomoides anisochila* is included in the actual edition of the Red Data Book of Uzbekistan under category 2 (more or less corresponds with IUCN category EN) (Khasanov et al. 2019). In previous editions of the National Red Data Book, it was listed under category 1 (Critically Endangered). The species has never been cultivated *ex situ*, and its seeds are not conserved in any germplasm bank.

Conservation actions needed: Expansion of the territory of the Nuratau Nature Reserve, regulation of livestock grazing and prohibition of mining and geological exploration in the species habitats. Research and monitoring activities are recommended to better understanding of the reproductive biology of the species, ecology, threats, and population trends, as well as the development of cultivation methods, re-introduction and seed banking.

Giuseppe Fenu, Natalya Y. Beshko, Khabibullo F. Shomurodov, Bekhruz S. Khabibullaev

References

Adylov TA (1987) Genus *Paraeremostachys* Adylov, Kamelin et Makhm., in Conspectus Florae Asiae Mediae, 9. Fan Publishers, Tashkent 78–82. [In Russian]

Aeschimann D, Lauber K, Moser DM, Theurillat J-P (2004) Flora alpina. Zanichelli Editore, Bologna, 1–2600.

Akhmedov A, Beshko N, Keldiyorov X, Umurzakova Z, Hasanov M, Atayeva S, Rasulova Z, Nematov S, Sherkulov M, Jumayev N (2023) Ontogenetic structure of populations of *Phlomis nubilans* (Lamiaceae) in Uzbekistan under drought climate. Ekologia (Bratislava) 42(4): 349–353. https://doi.org/10.2478/eko-2023-0039

Antkowiak W, Janyszek-Sołtysiak M, Klimko M (2018) Taxonomic significance of seed-coat microsculpturing in *Noccaea* Moench and *Thlaspi* L. (Brassicaceae: Coluteocarpeae, Thlaspideae). Nordic Journal of Botany 36(12): 1–16. https://doi.org/10.1111/njb.02037

Bachman S, Moat J, Hill AW, Torre J de la, Scott B (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. In: Smith V, Penev L (Eds) E-Infrastructures for data publishing in biodiversity science. ZooKeys 150: 117–126. https://doi.org/10.3897/zookeys.150.2109 [Version BETA]

Beshko NY (2018) Endemic plants of the Nuratau mountains (North-Western Pamir-Alay). Uzbek Biological Journal 4: 13–18.

Beshko NY (2020) Flora of Central Asia: the Nuratau Mountains. Korea National Arboretum, Pocheon, 432–432.

Englisch T, Valachovič M, Mucina L, Grabherr G, Ellmauer T (1993) *Thlaspietea rotundifolii*. In: Grabherr G, Mucina L (Eds) Die Pflanzengesellschaften Österreichs. Teil II: 276–342. Gustav Fischer Verlag, Jena.

Ernst W (1974) Schwermetallvegetation der Erde. Gustav Fischer, Stuttgart.

Fellet G., Pošćić F, Casolo V, Marchiol M (2012) Metallophytes and thallium hyperaccumulation at the former Raibl lead/zinc mining site (Julian Alps, Italy). Plant Biosystems 146(4): 1023–1036. https://doi.org/10.1080/11263504.2012.703250

Fenu G, Al-Rammahi HM, Cambria S, Cristaudo AE, Khabibullaev BS, Mohammad MK, Shomurodov KF, Tavilla G, Orsenigo S (2022) Global and Regional IUCN Red List Assessments: 14. Italian Botanist 14: 81–94. https://doi.org/10.3897/italianbotanist.14.97176

Fischer MA, Oswald K, Adler W (2008) Exkursionsflora fur Österreich, Lichtenstein, Südtirol. 3. Auflage. Biologiezentrum der Oberösttereich Landemuseen, Linz.

Gortani L, Gortani M (1905–1906) Flora friulana: con speciale riguardo alla Carnia. Tipografia Doretti, Udine.

IUCN (2022) Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1. IUCN Standards and Petitions Committee. https://www.iucnredlist.org/documents/RedListGuidelines.pdf [accessed 3 december 2024]

IUCN (2024) The IUCN Red List of Threatened Species. Version 2024-2. https://www.iucnredlist.org [accessed 3 december 2024]

Jakovljević K, Mišljenović T, Brueckner D, Jacquet J, Michaudel G, van der Ent A (2024) Elemental localization in inflorescences of the hyperaccumulators *Noccaea praecox* and *Noccaea caerulescens* (Brassicaceae). Ecological Research 39(4): 588–595. https://doi.org/10.1111/1440-1703.12473

Khassanov FO, Kuchkarov BT, Tojibaev KSh, Pratov UP, Belolipov IV, Shomurodov HF and Beshko NYu (2019) The Red Data Book of The Republic of Uzbekistan. Tasvir, Tashkent., 267–267.

Lausi D, Cusma Velari T (1992) Cariologia di taxa critici su suoli calaminari (Cave del Predil, Alpi Giulie, Italia). Studia Geobotanica 12: 153–167.

Magauer M, Schönswetter P, Jang TS, Frajman B (2014) Disentangling relationships within the disjunctly distributed *Alyssum ovirense/A. wulfenianum* group (Brassicaceae), including description of a novel species from the north-eastern Alps. Botanical Journal of the Linnean Society 176(4): 486–505. https://doi.org/10.1111/boj.12214

Makhmedov TA (1987) Genus *Phlomis* L., in Conspectus Florae Asiae Mediae, 9. Fan Publishers, Tashkent, 107–113. [In Russian]

Martini F (1987) L'endemismo vegetale nel Friuli-Venezia Giulia - The endemic flora of Friuli-Venezia Giulia. Biogeographia 13(1): 339–399. https://doi.org/10.21426/B613110214

Martini F (2024) *Noccaea Cepaeifolia* (Wulfen.) Rchb. In: Bertolli A (Ed.) Flora endemica del Nord Italia. Fondazione Museo Civico di Rovereto. Athesia Verlag, 340–340

Martini F, Bertani G, Boscutti F, Bruna A, Danelutto A, Pavan R, Peruzovich C (2023) Flora del Friuli-Venezia Giulia: repertorio critico diacronico e atlante corologico. Forum, Udine.

Orsenigo S, Fenu G, Gargano D, Montagnani C, Abeli T, Alessandrini A, Bacchetta G, Bartolucci F, Carta A, Castello M, Cogoni D, Conti F, Domina G, Foggi B, Gennai M, Gigante D, Iberite M, Peruzzi L, Pinna MS, Prosser F, Santangelo A, Selvaggi A, Stinca A, Villani M, Wagensommer RP, Tartaglini N, Duprè E, Blasi C, Rossi G (2021) Red list of threatened vascular plants in Italy. Plant Biosystems 155(2): 310–335. https://doi.org/10.1080/11263504.2020.1739165

Punz W, Mucina L (1997) Vegetation on Anthropogenic Metalliferous Soils in the Eastern Alps. Folia Geobotanica & Phytotaxonomica 32: 283–295. https://doi.org/10.1007/BF02804008

Schratt-Ehrendorfer L, Niklfeld H, Schröck C, Stöhr O [Eds] (2022) Rote Liste der Farn- und Blütenpflanzen Österreichs. Stapfia 114, Land Oberösterreich, Linz.

Tojibaev KS, Beshko NY, Kodyrov UK, Batoshov AR, Mirzalieva DU (2018) Inventory of the flora of Uzbekistan: Samarkand Province. Fan Publishers, Tashkent, 220–220. [In Russian]

Tojibaev KS, Beshko NY, Shomurodov KF, Abduraimov OS, Adilov BA, Akhmedov AK, Rakhimova T, Rakhimova NK, Sarybaeva SU, Khayitov RS, Sharipova VK (2019) Inventory of the flora of Uzbekistan: Navoi Province. Fan Publishers, Tashkent, 216–216. [In Russian]

Tojibaev KS, Beshko NY, Esankulov AS, Batoshov AR, Azimova DE (2021) Inventory of the flora of Uzbekistan: Dzhizak Province. Zamin nashr, Tashkent, 368–368. [In Russian]

Volis S, Beshko N (2023) How to preserve narrow endemics in view of climate change? The Nuratau mountains as the case. Plant Diversity of Central Asia 2(2): 82–101. http://doi.org/10.54981/PDCA/vol2_iss2/a3

Vvedensky AI (1961) Family Labiatae, in Flora of Uzbekistan, 5. Academy of Sciences of the Uzbek SSR, Tashkent, 263–417.